Quarterly

THE WATER TOWER

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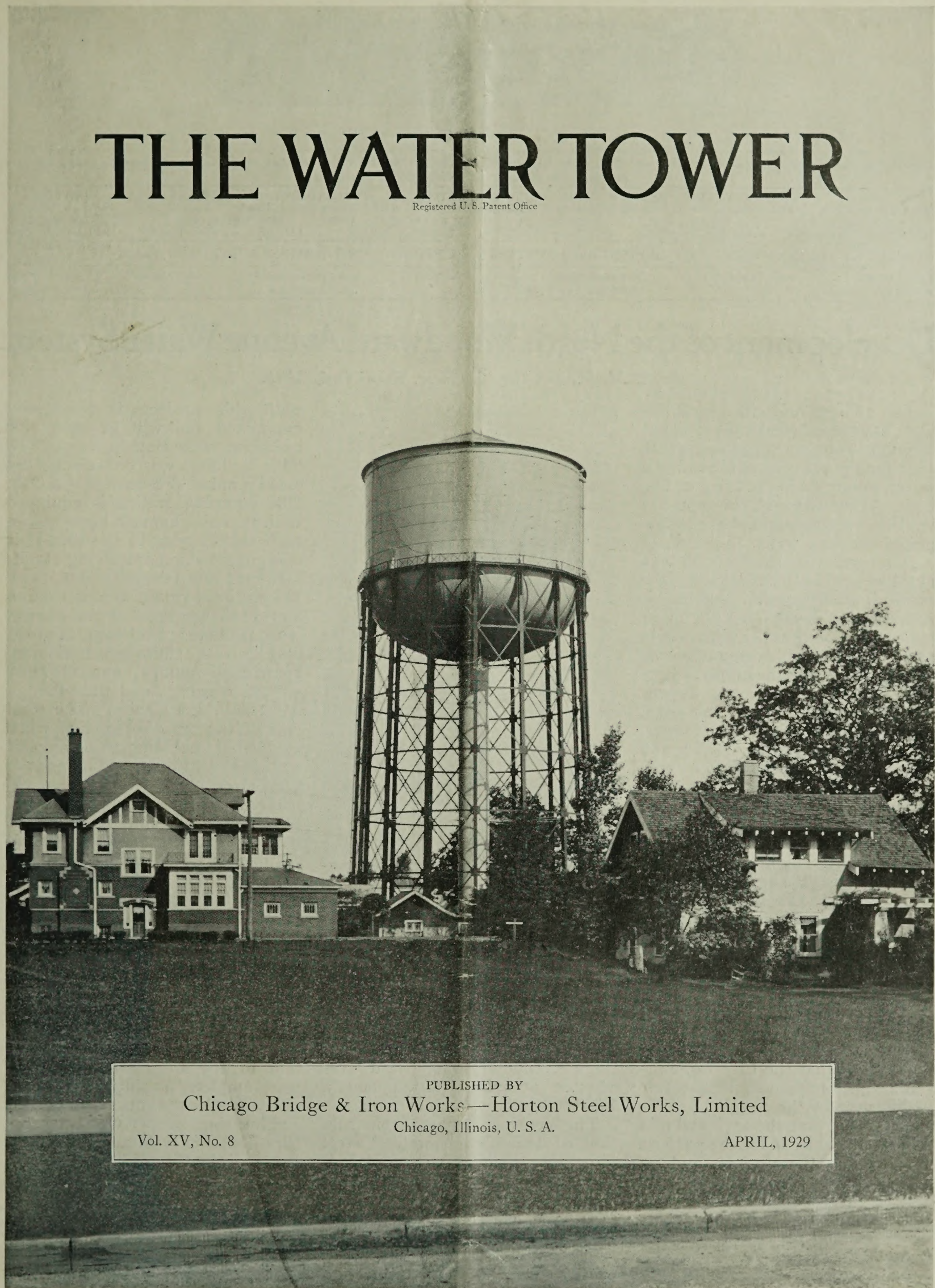

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1,500,000-gallon elevated tank in the North Woodward Avenue water system at Royal Oak, Michigan. See article on page 2.

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Development of the North Woodward Avenue Water System

By E. M. Shafter, City Engineer, Royal Oak, Mich.

The villages and cities in Royal Oak township (Oakland County, Michigan) began negotiations in 1923 for the purpose of obtaining a water supply from the City of Detroit. At that time all communities in the township derived their supplies from deep wells.

It was felt that there would be a rapid growth in the area during the succeeding ten years, making it necessary to develop a large number of additional wells. This would mean a considerable demand on the underground water supply. Furthermore, it had been the experience of communities using such supplies, especially the larger ones, that deep wells are unreliable and cannot be depended upon to furnish an uninterrupted flow of water.

Several different schemes were advanced by officials of the villages and cities of Royal Oak township whereby they might secure water from Detroit. However, after several years it was found that no agreement could be reached.

The City of Royal Oak was growing so rapidly during this time that it became necessary to increase the water supply by putting down additional wells. The problem of securing a permanent and dependable supply was of such importance that the City Commission decided to submit the question to the vote of the people.

The result was the approval of a $500,000 bond issue for the purpose of financing the project, and an agreement was reached with the City of Detroit in March, 1927. Plans were prepared immediately for developing part of the ultimate North Woodward Avenue water system project.

Construction view of the 1,500,000-gallon elevated tank while being erected at Royal Oak, Michigan.

This work included the construction of a 48-inch steel water main from the south edge of the township northward in Livernois and Oakridge Avenues to Woodward Avenue; a pumping station and a 1,500,000-gallon elevated tank.

The contract for the construction of the 48-inch welded steel pipe, approximately two and one-half miles in length, was awarded to a local concern in November, 1927, and completed during the summer of 1928.

The pumping station, which had to be constructed in connection with this project, is practically completed and will be ready for operation some time in April, 1929. This building was constructed by Lee Campbell & Son, of Royal Oak. The pumping station is equipped with two air chamber tanks to absorb any surging in the lines; air compressor and receiving tank; 1-10-inch and 1-14-inch cone check valves; gate valves on the suction and discharge lines of the pumps, with manual and electric control; and two Worthington horizontal centrifugal pumps, one of 2,500 G.P.M. capacity, and the other of 5,000 G.P.M. capacity. The total cost of the pumping station when completed, including all equipment and special fittings, will amount to $76,000.00. Sufficient pumping capacity has been provided to furnish ten and one-half million gallons of water per day.

In order to provide adequate water pressure in the outlying districts of the North Woodward Avenue water system it was found necessary to construct the 1,500,000-gallon elevated water tank at the location shown on the accompanying map. The elevation of high water in this tank will be 818.5, which is 149 feet above the base of the steel columns. The construction of the 1,500,000-gallon tank was completed during the summer of 1928 under the supervision of the Engineering Department of the City of Royal Oak, and the Water Board of the City of Detroit. From a comparison of the amount of steel in this structure it is believed that the Royal Oak tank is the largest in the world of this type, there being, approximately, 1,400,000 pounds of steel in the structure.

There are other tanks of greater capacity, although they are not as high as the Royal Oak tank.

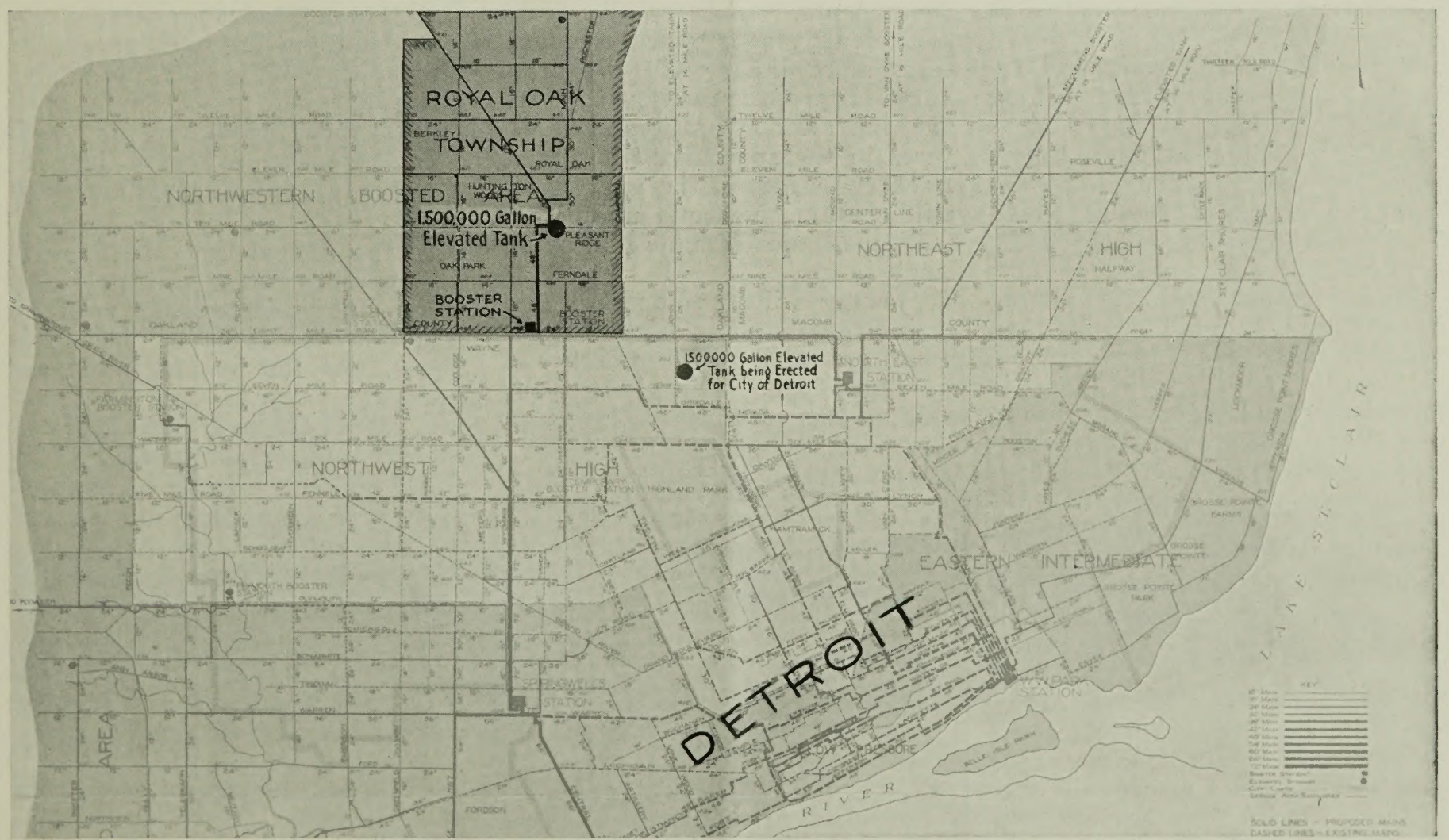
The elevated tank is located opposite the East side of the Detroit Zoological Park in a block, which at present, is built up of commercial and residence buildings, as shown by the picture on the front cover of this issue. Although there has been some criticism relative to the location of the tank, it is believed that the majority of the residents in the vicinity do not consider the structure to be unsightly and objectionable. The tank proper and the riser pipe have been painted a silver gray color, and the steel columns have been painted black. It is believed that this contrast is more pleasing to the eye than if the entire structure had been painted black.

At the present time in the City of Royal Oak, there are approximately 110 miles of water mains, ranging in size from 4 inches to 48 inches, serving an area of nine square miles. However, about 30% of this area is undeveloped. At present the city consumes an average of one and one-half million gallons of water per day. During the summer months, however, the consumption increases to as much as two and one-half million gallons. The maximum demand rate is, approximately, three million gallons per day. The immediate users of water to be obtained from the North Woodward Avenue system will be the City of Royal Oak, Village of Huntington Woods, Village of Oak Park, and the Detroit Zoological Park.

When the North Woodward Avenue system is entirely built up, the area served by this water supply will be about twenty-four square miles, including the Cities of Royal Oak, Ferndale, Pleasant Ridge; the Villages of Oak Park, Huntington Woods, Berkley, Clawson, and the unincorporated areas of the township of Royal Oak. It is estimated that the ultimate development in this area will require a water supply of forty-two million gallons per day, and it is to this end that the North Woodward Avenue system is being built.

The water which will be furnished to the North Woodward Avenue system will have its source in Lake St. Clair, similar to that of the City of Detroit. This water will pass through the Detroit filter plant, and be pumped through the Detroit distribution system to the Booster station, which has been constructed just North of the Eight Mile Road. The map indicates the Gridiron System of the North Woodward Avenue water system, which is the ultimate development and plan which must be followed in extending water mains in this area. All communities which are served by the system must abide by the regulations of the Detroit Water Board, both as to the layout and details of construction of any extensions made to existing distribution systems. There is no doubt that in the future this area will be a part of greater Detroit.

It is felt that the development of the North Woodward Avenue water system, following closely to the plan as designed by the Detroit Water Board Engineers, will effect considerable saving to the tax payers of this district during the ensuing years. Instead of developing water supplies for individual communities in a piece-meal fashion, to be abandoned after several years of use, it would seem that it would be much more economical to develop the one major water supply project, gradually building it up to meet the needs of the district.



Northern portion of Detroit metropolitan area showing water distribution transmission mains. The location of the 1,500,000-gallon elevated tank at Royal Oak is indicated as well as the location of a similar sized structure which we are erecting for the City of Detroit at the present time.

Evaporation Losses and Their Prevention

H. C. Boardman

A clear mental picture of the process of evaporation is essential to an understanding of the methods of preventing evaporation losses. This fact justifies the space devoted in this paper to discussing evaporation and the terms associated with it.

Except when crude oil, or gasoline, is being discussed the word liquid will be understood to apply to simple liquids like water, alcohol, or mercury.

The molecules of which a liquid is made are in rapid motion at a rate which depends entirely upon the temperature. If there is space above the liquid some of the molecules constantly shoot out into it. The number which leave the liquid per square inch of surface per second, and their velocity, depend upon the temperature. The warmer the liquid is, the faster the molecules move and the more of them leave. This process of separation of molecules from the liquid is called evaporation.

If a liquid be put into a tank free from air (a vacuum) the molecules which evaporate are confined within the tank. They hit each other, and the sides, and roof, and rebound, and some return to the liquid. Eventually a condition is reached in which equal numbers leave and return. Then the vapor, made up of the molecules which have left the liquid, is said to be *saturated.*

Vapor becomes saturated almost immediately if liquid be put in a vacuum tank, but if the tank be filled with air when the liquid is introduced, and the air and liquid do not unite chemically, the saturation is much slower. The delay may be thought of as caused by collisions between the air and vapor molecules. Although the air retards the saturation, it does not in any way affect the final degree of saturation. At a given temperature just as much liquid will evaporate into an air-filled tank as into a vacuum tank. Each cubic foot of space, whether air be present or not, will contain a definite number of vapor molecules moving at a definite average velocity.

Some of these moving molecules are continually hitting the sides and roof of the tank, and bounding away. The impact of their bombardment causes pressure, known as the *vapor pressure* of the liquid, which depends only upon the temperature.

The air molecules strike the sides and roof of the tank practically as if the vapor were not present. Therefore, the total pressure is the sum of the vapor pressure and the pressure the air would exert if it alone filled the space occupied by the air and vapor.

If several liquids and gases which do not mutually dissolve one another or unite chemically were put into the tank, each would exert the same pressure that it would if it alone were present, and the total pressure would be the sum of their separate or *partial* pressures. However, if liquids and gases which do mutually dissolve one another or unite chemically were put into the tank, the total pressure would not be the sum of their separate pressures. The vapor pressure of a solution is always less than the sum of the pressures of its components.

Evidently, at a given temperature, more liquid will evaporate into a large space than into a small one, but after saturation the pressures in the spaces will be equal. Each cubic foot of the large space will contain the same number of molecules as each cubic foot of the small space.

Therefore, if the temperature remains constant, the pressure of a saturated vapor in the presence of its liquid cannot be changed by making the vapor space larger or smaller. If there is no vapor space —that is, if the roof of the tank is in contact with the liquid, no vapor can form, but the pressure upward against the roof is just the same as if vapor could form. If the roof is raised off the liquid surface, or the liquid level lowered, keeping the temperature constant, liquid will evaporate to maintain the pressure; if the vapor space be decreased without a change of temperature some of the vapor will turn into liquid, leaving the pressure unchanged.

If so little liquid be put into a tank that it all evaporates, the vapor is unsaturated (or superheated) because more liquid would evaporate into it if more were present. If the unsaturated vapor be cooled it will be found that at some temperature liquid will appear on the tank bottom. The vapor will then be saturated. Likewise, if unsaturated vapor be compressed sufficiently, liquid will form and the vapor be saturated. Mental pictures of what happens in both cases can be formed. In the unsaturated state the molecules are widely separated and moving rapidly. As the temperature falls the molecules move more and more slowly until finally their attraction for each other begins to overcome their kinetic energy, and they unite to form liquid.

In the second case the increasing pressure forces the molecules closer and closer together until cohesion unites some of them into liquid. At the instant liquid appears the vapor is saturated; contains all of the molecules it can at the existing temperature.

Air and other gases are simply vapors far removed from their saturation states. For gases, the changes in pressure, temperature, and volume vary in accordance with Boyles and Charles law, which states that $\frac{PV}{T} = K$, where P is the absolute pressure (gauge pressure plus atmospheric pressure), V is the vapor volume, T is the absolute temperature (reading of a Fahrenheit thermometer plus 460°), and K is constant. The same law holds approximately for vapors not far from their satura-

Mr. Boardman has described, in this article, the process of evaporation in a simple non-technical manner which is understood readily. In the summary he suggests several ways of preventing or reducing evaporation loss from oil, one of which is the use of Floating Roofs. The practicability of Wiggins Floating Roof is exemplified by the wide-spread installations illustrated on these pages. They include locations in India, Argentine, Mexico, New Zealand and Hawaii. Wiggins Roofs operate and should be given some care. The attention required, however, is not such that oil companies need hesitate in locating them in out-of-the-way places where highly trained men are not in attendance.

tion states. The relations between saturated vapor pressures and temperatures are more complex, and it is customary to refer to tables or charts to obtain them. Each liquid has its own vapor pressure-temperature curve.

For the special case of air changing volume without the addition or subtraction of heat, $PV^{1.4}$ is constant. The exponent 1.4 is the ratio of the specific heat of air at constant pressure to the specific heat of air at constant volume.

If a liquid be put into an uncovered tank and heated until its vapor pressure equals atmospheric pressure, it will begin to vaporize visibly (will agitate the surface), and be said to boil. While boiling is commonly understood to be at atmospheric pressure, it may be at higher or lower pressures. Water at sea level boils at a higher temperature than on a mountain top. Strictly speaking, a liquid boils whenever its vapor pressure equals the pressure to which it is subjected. While a liquid is boiling at constant pressure its temperature does not change, but heat must continually be applied to keep it boiling. This heat, which must be applied to change a liquid into vapor at the boiling temperature, is called the *heat of vaporization.*

Vaporization, whether by evaporation or by boiling, requires heat. For example, heat is taken from the atmosphere when water is allowed to evaporate from an open vessel or when oil is evaporated in a storage tank. Therefore, evaporation is a cooling agent. The greater the quantity of heat used to raise a liquid to the boiling temperature the less will be the heat necessary to change it into vapor by boiling. In other words, an increase in boiling temperature (and pressure) reduces the heat of vaporization. Less heat is required to change water at boiling temperature at sea level into vapor than is required to change an equal quantity into vapor at boiling temperature on a mountain top. At the critical temperature (and critical pressure) the heat of vaporization is zero. The critical pressure is the highest vapor pressure a liquid can develop. Above the critical pressure and temperature a substance can exist only as a gas.

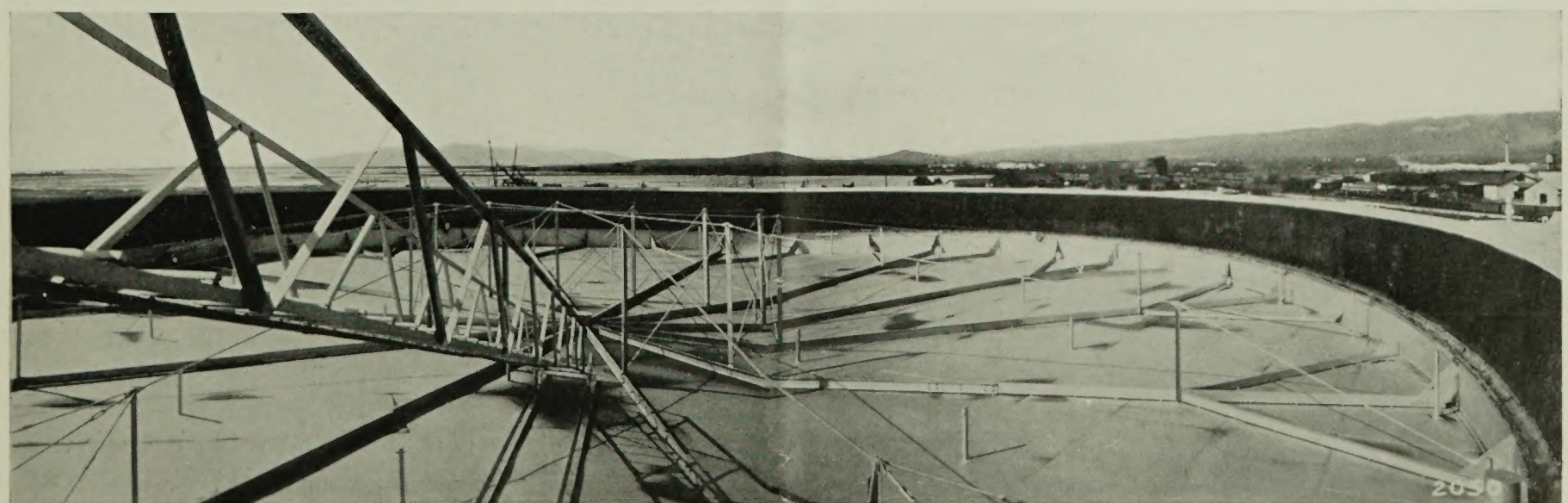
All that has been said about the evaporation and boiling of water and other simple liquids applies in a general way to petroleum or any of its liquid derivatives. However, since crude oil consists of several hydrocarbons, together with some oxygen, nitrogen, and sulphur, its evaporation problems are very complicated. Some of the components are gases, some liquids, and some solids when in their pure states. They are present in varying amounts, and in such a manner that oil in storage stratifies to some extent with the lightest and most volatile portions at the top. The lighter fractions boil first and the heavier ones follow at higher temperatures. What has previously been said about the vapor pressure of solutions makes obvious how extremely difficult is the problem of determining the vapor pressures of crude oil from known characteristics and quantities of its components.

During evaporation or boiling, when both liquid petroleum and vapor are present, the composition of each is different at every temperature, and neither has the same composition as the original liquid. The same thing is true of gasoline or any of the other liquid derivatives of petroleum. Therefore, the vapor pressure is to some extent dependent on the size of the vapor space.

As oil boils, the vapors may be cooled and liquefied. This process is distillation. In making standard A. S. T. M. laboratory distillation tests a quantity of oil is heated in a flask by a Bunsen flame below the flask, the vapors are run to a condenser open to the atmosphere, and when the first drop condenses the temperature is read from a thermometer in the neck of the flask in the vapor space opposite the side outlet leading to the condenser. The temperature thus read is commonly called the Engler initial boiling point, or simply the *initial boiling point.* The temperature similarly read when the liquid has entirely boiled off is called the *end point.*

All of crude oil which boils off up to 410° F. is commonly called gasoline and naphtha; kerosene follows between 410° F. and 572° F. Above 572° F. the hydrocarbons not already distilled partially decompose with the result that some gasoline is obtained along with heavier products.

The process of breaking down heavy hydrocarbons into lighter ones by heating is called cracking. Cracking can be done in the semi-liquid phase with distillation, as just explained, at atmospheric or higher than atmospheric pressure; entirely in the vapor phase at atmospheric or higher than atmos-



Sectional view of 117-foot diameter Wiggins Floating Roof furnished the Shell Company of California for an 80,000-barrel tank at Honolulu, T. H.

pheric pressure; or entirely in the liquid phase at very high pressure.

For various reasons temperatures read in the vapor space during an Engler distillation of crude oil or gasoline are lower than the corresponding temperatures of the boiling liquid. Therefore, it is not surprising that efforts to discover a good relation between Engler initial boiling points and vapor pressures have failed. In determining the boiling point of crude oil or gasoline as a basis for calculating vapor pressures, the thermometer should be *in* the liquid instead of in the neck of the flask. The first drop temperature read from a thermometer in the liquid is called the *true* initial boiling point or simply the *true* boiling point, to distinguish it from the Engler initial boiling point.

It has been discovered that if temperature logarithms for pure hydrocarbons be plotted against the saturated vapor pressure logarithms, the resulting curves will be nearly parallel; also that the same thing is approximately true for gasoline; and roughly true for crude oils. (See "The Physical Properties of the Paraffin Hydrocarbons," by Robert E. Wilson and W. H. Bahlke, in the February, 1924, issue of Industrial and Engineering Chemistry.) Chart No. 1A was prepared on this basis. To determine the approximate vapor pressure of petroleum or any of its liquid products at any temperature it is therefore necessary merely to know the *true* boiling point (which is generally from 30° F. to 60° F. higher than the Engler initial boiling point), locate it on the line marked "True Boiling Pressure" on the chart, construct through the point thus located a curve fitting in between the nearest curves shown, and read the desired pressure opposite the intersection with the ordinate through the proper temperature. Chart No. 1B gives similar information in what is for some purposes a more convenient form.

It requires about ½ B.T.U. to raise one pound of gasoline 1° F. and 135 B.T.U. to change one pound of gasoline at atmospheric pressure into vapor. As compared with these the figures for water are 1 B.T.U. and 966 B.T.U., respectively. These data make clear the fact that much less heat is required to vaporize gasoline than water.

In the literature dealing with evaporation, a space containing gasoline vapor and air is frequently said to contain a certain percent of air and a certain percent of vapor. This is misleading since, if no air were present, the amount of vapor in the space at the same temperature would be just the same as with the air present. What is really meant is that the vapor pressure is a certain percent of the total pressure, and the air pressure the remainder.

This condition is also sometimes described by saying that a certain percent of gasoline vapor is necessary to saturate the air at the existing temperature. Strictly speaking, it is the *vapor* itself, or the *space,* which is saturated.

The volatility of gasoline or petroleum is not dependent on gravity alone. For example, a gasoline made by blending casing-head gasoline (a gasoline compressed or refrigerated from natural gas) with naphtha has a low initial boiling point, but a high end point. A 58° Be. (specific gravity $= \frac{140}{130 + \text{Baume}^\circ}$) blended gasoline might have an initial boiling point of 100° F. and a 58° Be. straight-run (distilled) gasoline might have an initial boiling point of 190° F. Crudes from the McCamey Field, Uptown County, Texas, and the Chalk Field, Howard County, Texas, have about the same gravity (26° Be.), but the initial boiling point of the former is 158° F., and of the latter 86° F. However, it is true that, in a general way, gravity is an indication of volatility. On Chart No. 1A the gravities of ordinary commercial gasolines appear over the curves, which are commonly assumed to be their temperature-vapor pressure curves. Gravity should be used as a basis for obtaining vapor pressures only when the true boiling point is unknown.

When gasoline or petroleum is stored in tanks the temperature in the vapor space is not uniform. The heat from the sun is applied to the roof and sides of the tank and has to pass downward and laterally through the vapor to reach the oil surface. The plates absorb heat, and by radiation, conduction and convection, transmit some of it through the vapor to the oil.

Since heat does not flow by conduction except from regions of higher to regions of lower temperature there must be a temperature gradient from the roof downward, and from the sides inward and downward. Because air and vapor are poor heat conductors they, to some extent, shield the liquid surface from the heat of the sun. The result is that the upper levels of the vapor are unsaturated, and only the vapor directly above the liquid surface is fully saturated. However, as far as is known, the vapor pressure in the whole vapor space may, for practical purposes, be taken as that corresponding to the liquid surface temperature.

The truths about evaporation which have been discussed may be summarized as follows:

(1) Below boiling temperatures the departure of molecules from the parent liquid in the form of vapor is evaporation.

(2) If the space above the liquid were a vacuum of infinite volume, the rate of evaporation would depend entirely upon the temperature.

(3) If the space above the liquid is a vacuum in a closed container the vapor molecules bound off the sides and top and some return to the liquid. Eventually as many return as leave. Then the vapor is *saturated.* Saturation is almost immediate in a vacuum—but takes an appreciable time in air.

(4) The degree of saturation, if sufficient time be given, is the same, whether or not air be present, unless the air and liquid unite chemically.

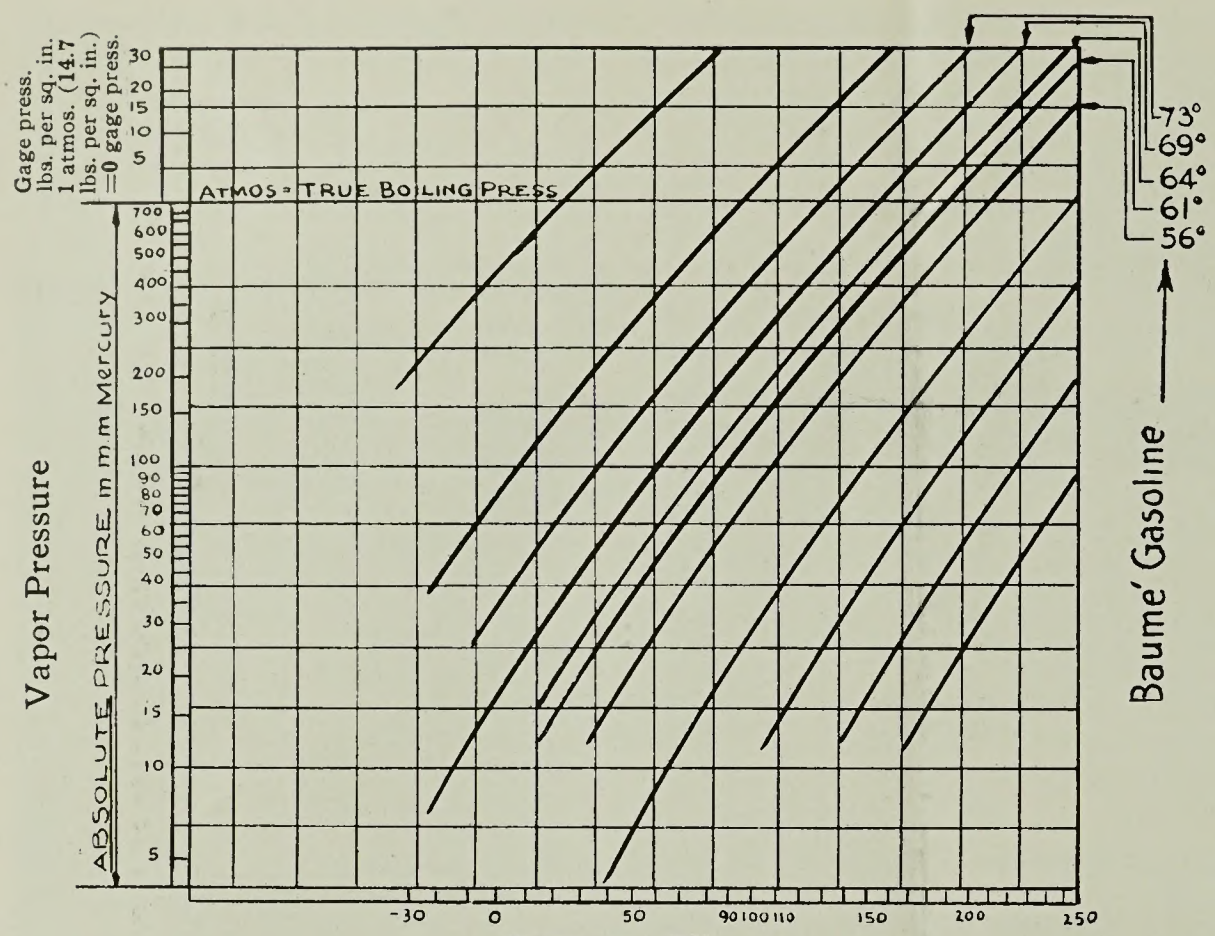
(5) The impact of the vapor molecules against the restraining surfaces constitutes vapor pressure. For a given liquid it depends entirely upon temperature, and is the same, whether or not air or other gases or liquids be present, provided they do not mutually dissolve one another or unit chemically. In other words, the total pressure is the sum of the separate pressures. The contribution of each gas or vapor to the total pressure is called its *partial* pressure.

(6) The vapor pressure of a solution is less than the sum of the pressures of its components.

(7) Saturated vapor is vapor in a closed space in contact with the liquid from which it came—the temperature throughout the vapor being uniform. An increase in the vapor space without a change in

This 37,500-barrel Horton tank at Dock Sud, Buenos Aires, Argentine, is equipped with a Wiggins Floating Roof. It and a 55,000-barrel tank and roof were furnished for "Astra" Compania Argentina de Petroleo, S. A.

Wiggins Floating Roof 114½ feet in diameter which was installed on an existing tank at Budge Budge, Calcutta, India, for the Burma-Shell Oil Storage and Distributing Company of India, Limited.



Curves showing Vapor Pressures vs. Temperatures
The curves shown for Gasoline are for Ordinary Commercial Gasolines

To use this chart, obtain the true boiling point of the liquid under consideration, locate it on True Boiling Pressure line, and draw through this point a line corresponding to the nearest curves shown. The resulting curve will be the Vapor Pressure vs. Temperature Curve for the liquid.

The True Initial Boiling Point (True Boiling Point) is the first drop temperature in a regular A.S.T.M. Engler Distillation read from a thermometer in the liquid. It is usually from 30° F to 60° F higher than the Initial Boiling Point read with the thermometer in the neck of the flask.

Average coefficient of expansion for $\begin{matrix}\text{Gasoline} = .00060 \\ \text{Crude Oils} = .00045\end{matrix}$

Roughly, the number of cu. ft. of Oil Vapor to One Gal. of Oil $= 30 \dfrac{\text{Atmospheric Pressure}}{\text{Oil Vapor Pressure}}$

Atmospheric Pressure = 14.7 lbs. per sq. in. = 29.92" Mercury = 760 mm Mercury.
1 lb. per sq. in. = 51.7 mm Mercury. 100 mm Mercury = 1.934 lbs. per sq. in.
Casinghead Gasoline Averages 80° to 100° Baume.
Ordinary Commercial Gasoline Averages about 61° Baume.

$$\text{Specific Gravity} = \frac{140}{130 + \text{Baume}^\circ} \qquad \text{Baume}^\circ = \frac{140}{\text{Specific Gravity}} - 130.$$

Chart No. 1A

temperature simply results in the evaporation of more liquid; a decrease simply results in the condensation of some vapor. In both cases the vapor pressure remains unchanged.

(8) Unsaturated or superheated vapor may be saturated either by cooling or compressing until condensation appears.

(9) Air and other gases follow the law $\frac{PV}{T} = K$. Unsaturated or superheated vapors near their saturation states also approximately follow this law. Saturated vapors, however, depend only upon P and T, which have a more complex relation than for gases, as shown by Charts No. 1A and No. 1B.

(10) After the vapor pressure of a liquid equals the pressure to which the liquid is subjected, a continued application of heat at the previous rate causes vaporization (called boiling) without raising the temperature of the liquid. The heat required to change a liquid into a vapor at a given pressure (and necessarily temperature) is called the *heat of vaporization.*

(11) All vaporization, both at and below boiling temperatures, requires heat which is apparently lost, but which is regained when the vapors are condensed.

(12) An increase in pressure raises the boiling temperature, but reduces the heat of vaporization.

(13) Crude oil is a complex substance made of several hydrocarbons, and boils through a wide range of temperatures. Consequently, the vapor pressure is to some extent dependent on the size of the vapor space as well as on the temperature. The temperature when boiling begins, as determined in an Engler A. S. T. M. distillation, is called the initial boiling point; the temperature at which it ends is called the end point. These temperatures are read in the vapor space.

(14) If the temperature when boiling begins is read from a thermometer *in the liquid* it is called the *true* boiling point. True boiling points are a better basis than gravity for comparing volatilities.

(15) There are usually temperature gradients in the vapor spaces of oil storage tanks. Since the heat of the sun is applied from above, the vapor acts as a protective blanket to the oil. The vapor pressure may be taken as that corresponding to the temperature of the oil surface. The heat which reaches the oil is transferred from the roof and sides by radiation, conduction, and convection.

It follows that evaporation losses may be prevented or reduced by:

(a) Allowing the vapor and air mixture to change volume and do mechanical work without allowing vapors to escape. This is what the Breather roofs do.

(b) Building the tank strong enough to withstand the combined liquid and vapor pressures. This is what the Spheroid, Sphere and pressure tanks of other types do.

(c) Insulating the tank from the sun's heat. This is what coverings of brick, or water, or cork, or other insulating materials do.

(d) Allowing no vapor space. The Floating Roof and liquid Breather practically do this for all except boiling temperatures.

(e) Cooling systems such as sprays utilizing the cooling effect of evaporation; or circulating systems to cool the vapors, or to circulate the oil and reduce the temperature variation at the oil surface. This method has not been used to any great extent.

(f) Any combinations of a, b, c, d, and e.

This has been a discussion, without the use of mathematics, of the general question of evaporation.

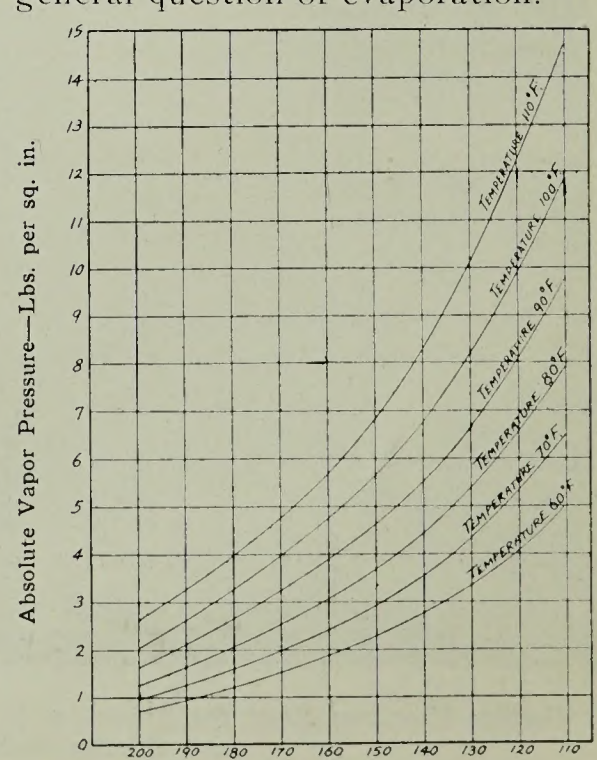


Chart No. 1B

Three 50-foot diameter Horton oil storage tanks equipped with Wiggins Floating Roofs at an oil company marine terminal at Auckland, New Zealand.

Wiggins Floating Roof, 90 feet in diameter, installed on a tank at the California Standard Oil Company de Mexico's Mazanillo station in the State of Colima, Mexico.

Sprinkler and Pulp Tanks at Ste. Anne Paper Mill

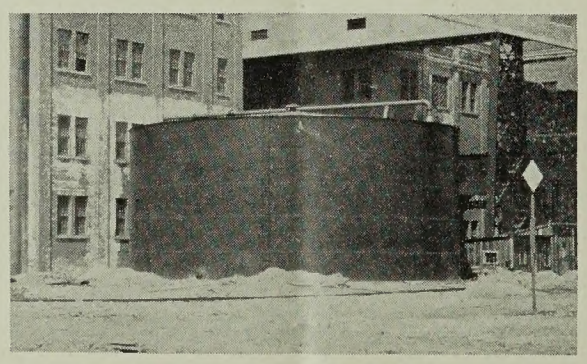
The Ste. Anne Paper Company mill is located twenty-three miles east of Quebec and about three miles from the famous shrine of Ste. Anne de Beaupre. There the Ste. Anne river flows into the St. Lawrence, providing docking facilities and wood handling conveniences. Power for the plant is brought by high tension lines from the Shawinigan hydro-electric plant up the river and from the Duke-Price power plant at Lake St. John.

Logs are brought to the mill on cars and dumped into a canal about 200 feet long and 12 feet wide. A large pump takes water from the mill end of the canal and puts it back at the far end, setting up a current which automatically carries the wood to the foot of the log haul for delivery to the barking drums.

This mill is equipped both for the making of sulphite pulp and ground wood. The sulphite plant is equipped with two burners which are located on the same level as the operating floor of the digester room, where they may be operated and supervised conveniently. A bronze pipe line is used for putting acid and steam into the digesters and for relieving excess liquor and gas as required.

Centrifugal pumps take the sulphide pulp from the blow pits and deliver it through large mains to a battery of Bird centrifugal screens. Ground wood is also delivered to a portion of the screens. In this connection, a 65-foot diameter by 30-foot high Horton tank is used for the storage of pulp.

The stock passes from the screens to the filters, where the pulp is thickened to a consistency between three and four percent, and then to reservoirs, one for sulphite and one for groundwood pulp. Next the two kinds of pulp are mixed in a predetermined proportion, color and alum added, and the mixture starts through the paper-making machines.



Pulp storage tank at Ste. Anne Paper Company mill. Above: General view of the mill showing 150,000-gallon elevated tank for fire protection.

The paper comes from the machines, is wound into rolls and passes directly out to the finishing room. Here they are rolled over the wrappers laid on the floor, the ends are folded in and the heads slipped on and pasted. After that the roll is lined up by sliding it on rollers and rolled along to steam-heated heading machines. Then it is weighed, lowered to the shipping room floor below and loaded for shipment.

Among other things, this mill has an up-to-date fire protection system. It is equipped with automatic sprinklers, supplied with water by a 150,000 U. S. gallon elevated tank. Should a blaze break out any time of night or day, water under gravity pressure is ready to quench it.

George F. Hardy, consulting engineer, designed the plant.

40,000-gallon elevated tank for sprinkler service at the Georgetown Silk Company plant, Wilkes-Barre, Pa.

75,000-gallon elevated tank for sprinkler service at the Hupp Motor Car Company plant, Jackson, Mich.

This picture illustrates how easily a Hortonsphere can be landscaped. It shows a 36-foot installation for the Wisconsin Power & Light Company at Ripon, Wisconsin, almost hidden by shrubbery.

Harbisons Dairies Standardize on Milk Bottle Tanks

The development of milk pasteurizing and distribution in what might be termed the Metropolitan District of Philadelphia has been based on sound engineering and marketing principles, and as a result has kept pace with the demands for the safe production of high quality milk at an economical price to the consuming public. Many of the efficient methods in use in the dairy industry today had their original development in the Philadelphia district, otherwise the dealers in that district would have been unable to supply milk to the public on the same price "spread" that was in effect prior to the world war, and absorb all the increased cost of processing and distribution through increased efficiency in their operations.

50,000-gallon tank shaped like a milk bottle at the Tioga plant of Harbisons' Dairies, Philadelphia. It is flood-lighted at night and can be seen for three or four miles.

One of the prominent companies distributing milk and milk products in the Philadelphia district is the Harbisons' Dairies, whose services had its inception in 1865, in the neighborhood of their present main plant at Front and Diamond Streets. Their business has grown from a small beginning to a volume of approximately 150,000 quarts of milk distributed each day through what might be termed the northeastern section of Philadelphia. This company was one of the first to register with the Bureau of Health, conforming to their standards; as they have always sought to supply their customers with an absolutely safe product to safeguard the public's health.

The main plant at Front and Diamond Streets was erected in 1912, and at that time set a precedent for sanitary building construction and efficient methods of operation. The growth of their business developed very rapidly, making it necessary to erect another large, modern pasteurizing and distributing plant in the Frankford section, to take care of the demands in that district. This Frankford plant also presented a step in advanced methods, and occupies a ground area of approximately four acres, being completed in the early part of 1921. By 1927 it was necessary to develop a third new pasteurizing and distribution plant in what is known as the Tioga section of northeast Philadelphia. This plant was completed in the early part of 1928, making three large, modern pasteurizing and distribution plants in the northeast section of Philadelphia, all owned and operated by the Harbisons' Dairies.

The milk supply for these three plants is gathered from a large number of country milk stations located in the adjacent milk producing areas for the Philadelphia district. The milk is received at these country stations directly after milking, inspected for quality, and immediately cooled and shipped each day to the city plants.

The question of insurance was carefully considered when the plans for each city pasteurizing plant were in the process of development; and as a result of this consideration all three city plants were erected under the requirements of the Associated Factory Mutual Companies and equipped with overhead gravity sprinkler tanks as a source of water supply to the automatic sprinkler system which the insurance interests required for protection in the stables, the power house, and wagon shed sections of the plants. In developing the plans for the gravity water supply, it was decided that gravity tanks constructed of steel in exact proportions to the Harbisons' standard milk bottles should be installed and utilized as an advertising feature for each plant. Illumination with flood lighting projectors at night, under time control, was provided to increase the advertising value. This form of advertising was developed for the main plant, which was built in 1913. It worked out so satisfactorily that each of the succeeding plants were equipped in the same manner.

When the plans for the Tioga plant were developed, it was necessary to provide a separate sprinkler tank tower for the support of the tank; and to avoid the use of cumbersome foundation beams a Horton ellipsoidal type of tank was installed, in accordance with the plans furnished by the engineer for the plant. It has a capacity of 50,000 gallons and is equipped with a three-foot diameter riser. The installation of this gravity water supply and sprinkler system, which contains 550 heads, reduces the insurance rate to approximately one-third of what it would be without such a fire protection system.

In selecting the location for the special gravity tanks, they were placed to allow for the widest angle of visibility, in order to enhance their advertising value. As a result the tanks are visible from several directions and when illuminated at night can be seen for a distance of three or four miles. Each tank is painted and lettered in exact accordance with the bottles delivered.

to the customers and is, therefore, a reminder of Harbisons' milk.

All details of the construction and equipment of all three of the Harbisons' Plants were furnished and installed in accordance with plans and specifications furnished by William H. Timm, Engineer and Architect of Philadelphia. He specializes in the construction and equipment of milk and milk product plants, and has served the Harbisons' Dairies in that capacity for the last eighteen years. We are indebted to him for this information about Harbisons.

Training Course for Erection Foremen

The training course for prospective erection foremen inaugurated in March, 1928, is now a year old. During the year, sixty-four erection men have applied for the privilege of taking the course; twenty-four have dropped out and forty have shown a continued interest and are up-to-date with their studies. Of the sixty-four erection men who applied for the course, ten were regular foremen and some of these have continued to show an interest in the course.

Of the prospective foremen who took up the course during the year, twelve have been promoted to a foremanship. Others are in line for promotion when the need for additional foremen arises.

The object of this course is two-fold. First; it affords ambitious young erection men an opportunity to acquaint themselves with matters pertaining to recommended safe practices in the erection of our work, and also familiarizes them with the details of the foreman's paper work. The extent of a foreman's responsibilities, his conduct toward the customer and others with whom he comes in contact while erecting his work and various other matters pertaining to a field foremanship are outlined in this course.

Second; it affords the company an opportunity to become better acquainted with the most promising individuals in the field who may have the stuff in them to make good foremen. When the time comes that a new foreman is needed these men are the first to be given consideration.

To be eligible to take the course the applicant must be in our employ two years and must be recommended by his foreman. With our present facilities for handling this school work about forty is the greatest number that can be taken care of. When new applications are accepted, one of two things will be done. Either some delinquent will be dropped from the enrollment, or if there are no delinquents, the new applicant will be put on the waiting list. Stragglers are not encouraged to continue with this course and will be dropped without much ceremony.

The training course is carried on by mail with C. W. Hines of the Chicago office. The correspondence feature is particularly appropriate for a course of this nature since nearly all communications between the foreman and office are carried on by correspondence. We are enabled in this way to see how well the prospective foreman will get along with this phase of a foreman's duties.

Bridgeburg

We had the pleasure of having O. A. Bailey of the Chicago office with us on March 11th.

Joseph Lubrick has joined our engineering staff in the capacity of stenographer.

Robert Slowleigh, storekeeper in our machine shop, certainly believes in breaking even on a hockey game when it is impossible to win, as throughout the winter he has been betting Buffalo both ways and feels that he is ahead of the game.

Several of the boys in the machine shop are inquiring why Sam Jones arrived at work at 6:35 a. m. on March 12th. It was afterward found out that Sam's better half had left on a short trip, and we presume it was up to him to cook the breakfast. Evidently he did not spend much time in doing so.

Freddie Booz has finished installation of the large plate planer at the eastern end of the shop, and we feel that this is quite an acquisition to our tool line in the main building.

On Monday evening, March 25th, the Mutual Club wound up their activities for the season at the High School Gymnasium. During the past three months many gymnasts were turned out proficient along basket ball, hand ball and soft ball lines. Other members of the club were actively engaged throughout the season in aquatic stunts and became experts in fast swimming, high and deep diving.

On Wednesday, March 13th, through the kindness of Mr. Scheman, the engineering department was invited to dinner in Buffalo and to attend the meeting of the Engineering Institute of Canada. The speaker of the evening was Mr. A. A. Northrupt of Stone & Webster Engineering Corporation. Mr. Northrupt, by the aid of stereopticon and moving pictures, illustrated and described the development and installation of the large Conowingo hydro-electric power dam on the Susquehanna River in Maryland for the Philadelphia Power and Electric Company.

January Accident Standing

We suffered about the ordinary number of lost time accidents during February; in fact, a few more than in January, but they were not nearly so serious. The net result is that our severity rate has taken a decided turn to the good.

The standings of the various departments for February are as follows:

DEPARTMENT	Accident* Frequency	Accident** Severity
Chicago	0	.00
Greenville	33	.65
Bridgeburg	36	.26
Canadian Erection	47	1.12
Western Erection District	19	.07
Eastern Erection District	71	.39
Southern Erection District	114	2.00
Pacific Erection District	0	.00
Total U. S. Erection	59	.71

*Accident frequency is the number of lost time accidents per million man hours worked.

**Accident severity is the number of days lost per thousand man hours worked.

Lost Time Accidents

	Feb. 1929	Jan. 1929	Feb. 1928	2 Mo. 1929
NO. ACCIDENTS—				
Chicago	0	2	0	2
Greenville	2	0	0	2
Bridgeburg	1	2	0	3
Canadian Erection	1	1	3	2
Western Erection Dist.	2	3	3	5
Eastern Erection Dist.	4	4	2	8
Southern Erection Dist.	8	3	8	11
Pacific Erection Dist.	0	1	0	1
Total for U. S. Erection.	14	11	13	25
FREQUENCY RATES—				
Chicago	0	24	0	12
Greenville	33	0	0	16
Bridgeburg	36	72	0	54
Canadian Erection	47	74	114	60
Western Erection Dist.	19	29	43	24
Eastern Erection Dist.	71	98	56	83
Southern Erection Dist.	114	62	120	93
Pacific Erection Dist.	0	155	0	78
Total for U. S. Erection.	59	55	74	57
SEVERITY RATES—				
Chicago	.00	7.14	.00	3.60
Greenville	.65	.00	.00	.32
Bridgeburg	.26	1.18	.00	.67
Canadian Erection	1.12	.15	1.32	.75
Western Erection Dist.	.07	57.94	.45	28.75
Eastern Erection Dist.	.39	1.37	.17	.80
Southern Erection Dist.	2.00	.49	104.71	1.39
Pacific Erection Dist.	.00	529.22	.00	466.53
Total U. S. Erection.	.71	60.73	40.00	28.02

Organization News

Mr. George T. Horton and Mr. Hiram T. Horton spent March 5 in New York and sailed the following day for Maracaibo on the SS. *Carabobo* of the Red D Line. They will return by way of the Dutch West Indies, and plan spending a short time at our job in Aruba.

Merle J. Trees made trips to New York, Cleveland and Dallas offices during the past month.

Mr. and Mrs. George E. Borst recently moved into their new home in Penn-Wynne, a suburb of Philadelphia. Their new address is 227 Harrogate Road (Penn-Wynne) Philadelphia.

A. H. Heineman has been transferred from the Chicago sales office and took up his new duties in the New York office the early part of February. After living in Jersey City for a month "Arn" finally moved into a bachelor apartment in East Orange, N. J., with four other young men, so life no longer holds for him a fear of boarding house mistresses.

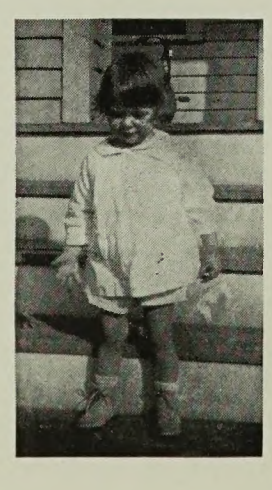
On February 23rd, Mr. H. B. Horton visited the New York office for the first time in several years. His stay, however, was a short one, as he left for Chicago the same day.

Other recent visitors to New York were Miss Emily Morrison, H. C. Boardman and O. A. Bailey.

Mrs. Genevieve Lanterman recently joined our San Francisco office force.

D. D. Williams, of Dallas, visited several erection jobs at Tampa and Jacksonville, Florida, during the latter part of March.

George S. Sangdahl of Cleveland spent the first week of March in Chicago attending the American Railway Engineering Association meeting.



The accompanying view shows Sally Anne Springer, 23-month old daughter of Chuck and Mrs. Springer at Cleveland, Ohio. Several copies of Manufacturers Record are numbered among the child's nursery books. She goes through them regularly, shouting "tank" whenever seeing a picture of one. As yet she does not distinguish between Horton tanks and the ordinary kind, but give her time.

C. H. Scheman, general manager of the Horton Steel Works, Limited, was recently elected a councillor of the Engineering Institute of Canada, representing the Niagara Peninsula Branch.

Main Office

R. K. Dupee has been appointed assistant Chicago district erection manager to help Joe Zeller with the inside work of that department. In the future Mr. Zeller will be enabled to supervise certain jobs personally and gain first-hand information as to the problems confronted.

O. A. Bailey returned on March 14 from a five-day trip to Bridgeburg, Paulsboro and New York.

John H. Wiggins spent a few days at the Main office and Chicago sales office the middle of March.

J. W. Switzer, formerly in the Chicago shop, is doing field work in the erection department. J. F. Marsh has also been transferred from the Chicago shop, being in the erection department office at present.

We have several new men in the drafting room. They are E. D. Barrett, C. M. Woo, R. F. Cummings, G. Schuster, S. W. Hockey and R. C. Flanary.

Avis Cruse is our new weight estimator, taking the place of Bart Rainey, who will have charge of the Workmens' Compensation Insurance.

Arnold Wessman is the proud owner of a new Model A Ford roadster.

Aubrey Seels made a trip to Petersboro, Ontario, to see his mother, who is seriously ill.

Edna Liljedahl, who had an operation some weeks ago, has recovered and is back at work again. Miss Hines, who took her place, is working on bonus records in the erection department.

H. C. Bennethum and T. L. Jarvis have been transferred to the shop.

Chicago Shop

We are installing a No. 3 Buffalo Bending Roll in our No. 2 Shop. This machine will be in operation shortly, and it is certainly an improvement over our old way of bending angles on the bull-dozers. This machine will bend angles leg out 6x6x¾ inches to a minimum diameter of 60 inches; angles leg out 5x5x¾ inches to minimum diameter of 72 inches; angles leg out 2½x2½x⅜ inches to a minimum diameter of 30 inches; and angles leg in 2x2x⅜ inches to minimum diameter of 36 inches. This machine will also bend I beams and channels. We have needed a machine like this for some time in our shop, and it will be a welcome improvement.

J. Hinkle has been put in charge of the bevel shears and ripping shears.

Niel De Vries, foreman of the templet shop, is stepping around in a new De Soto car.

J. Holtz of the fitting shop is the proud father of a 7¾-pound baby girl. Congratulations, John.

H. Greene has taken over the duty of handling the records for Job 77 and is now hard at it in the Shop Office. Welcome to our family, Greene.

Barney Miller, one of the old hands at the Chicago Plant, had an operation on March 9th at the Roseland Community Hospital. Barney is getting along fine for a man 73 years old. You can't keep a good man down.

The Chicago Plant went the month of February without a lost-time accident. It seems that we can go along for a while and then all of a sudden the bottom drops out. If all the men would just think about some of the chances they are taking each day, and would realize how close they have come to being injured, they would be more careful. It just goes to show you that if all the men try and all the foremen help things along accidents wouldn't occur. Let's keep up the good record and go along from month to month with a clean slate. Prevention each day keeps accidents away and a happy home. "SAFETY FIRST."

J. Piller of the Loading Yard has been home confined to bed. We hope to see him back on the job soon.

Greenville

William Malson, disher operator, returned to work at Greenville on February 20th after several months spent near Albuquerque in New Mexico. He liked the country there but reported work scarce and wages very low.

Field Foreman J. S. Elliott and Mrs. Elliott stopped at the plant on February 22nd on their way north from a job in North Carolina. They had difficulty negotiating some of the roads south of Greenville on account of the heavy snow.

Since February 26th, Warren H. Roth has been the father of a baby girl, Clair Emily, born on that date at the Greenville hospital.

Glenn McClure, night bevel shear operator, has returned to work after being absent for some time with a broken arm received while cranking his Ford car.

Harry Locke has been given the position of truck driver made vacant by the promotion of Fred Foulk to a position in the main office.

C. E. McGill, in charge of welding under Callahan, recently returned from a training course in electric welding at Schenectady, New York. He was quite pleased that the company afforded him this opportunity of increasing his knowledge of electric welding.

Charlotte Wolford, formerly of the Greenville office, but now at Hillside, New Jersey, is spending some time at home recuperating from an appendicitis operation.

Oscar Holmes of the Drafting Room rises to remark that even though his team finished second in the volley ball contest, he has partaken of three dinners at the expense of members of the winning team. Reply by said members: All betting is wrong.

Mr. and Mrs. Carl E. Ramsey are the proud parents of a baby girl, Sally Jane, born March 8th at the Greenville hospital.

Clarence Holmes is a confirmed vegetarian. Since leaving the parental roof in Chicago for the small confines at Greenville he has adapted himself to all the attending changes but does miss the fruit and vegetables he had at home. To alleviate some of his pangs, the office force presented, as a birthday offering, an enormous basket of the finest fruits and delicate vegetables they could gather in this district. Yes, there were some bananas also.

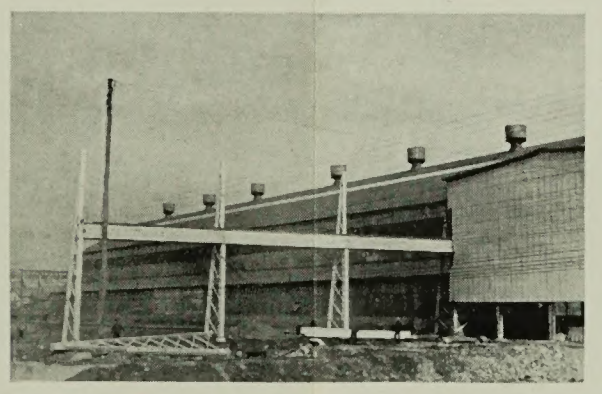
Volley Ball Dinner Won By Plate Shop Team—Main Office Second

Captain Harold Sellors' volley ball players from the main office and drafting room say that they are tired of chicken anyway. After winning the first two tournaments held this winter the shiny-pants boys allowed the plate shop team to take the third one, which was terminated in the matches held March 11th. Eighteen games were played by each of the four teams on six Monday nights at the Thiel gymnasium to decide the victors. A dinner for the winning team at the expense of the other three was the reward for supremacy in each of the three contests. The standings of the clubs at the close of the season was as follows:

	Won	Lost
Plate Shop and Shop Office	14	4
Main Office and Drafting Room	13	5
Old Shop	9	9
Machine and Forge Shop	0	18

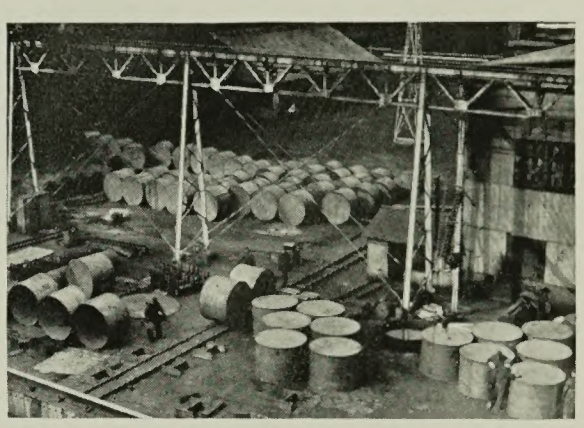
The victorious team was composed of T. F. Gilson, Paul McCright, R. W. Bechdol, L. A. Scott, Theo. Beil, Bill Hudson, John Titus, S. A. Smith and F. J. Harrison.

George Beck, the promoter of these matches, is arranging a final match between two teams, one from the combined shops and the other from the main and shop office players. This promises to be a real struggle.



Crane Extension Shows Progress

The picture appearing here, taken on March 1st from the southwest, shows three crane columns and girders in place and the last two north runway pieces being handled in preparation for raising them. This work has been moving along rapidly under the joint direction of William Tam and Joe Hendricks, both of whom are former field erection foremen. On March 13th both runways were erected so that it was possible to set the new 10-ton crane in place on the rails. This difficult work was rapidly completed with the assistance of the traveling crane or "whirlie" of the Bessemer and Lake Erie Railroad. No mishaps attended this operation which is considered hazardous. The last four cranes erected at Greenville have been been handled in the same capable manner without accident or injury to men or material. The work of erecting the roof trusses and enclosing the extension will be resumed after the ground fill has been completed.

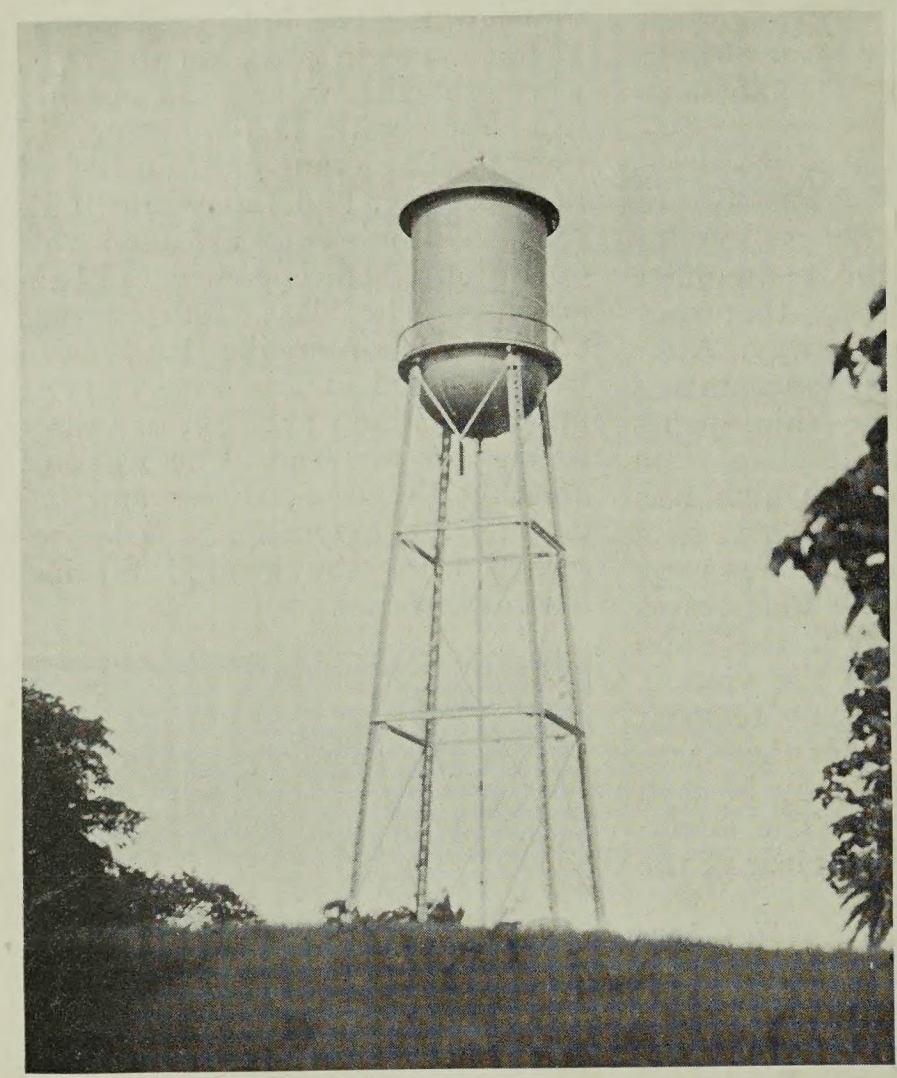


Welders Busy With Floats

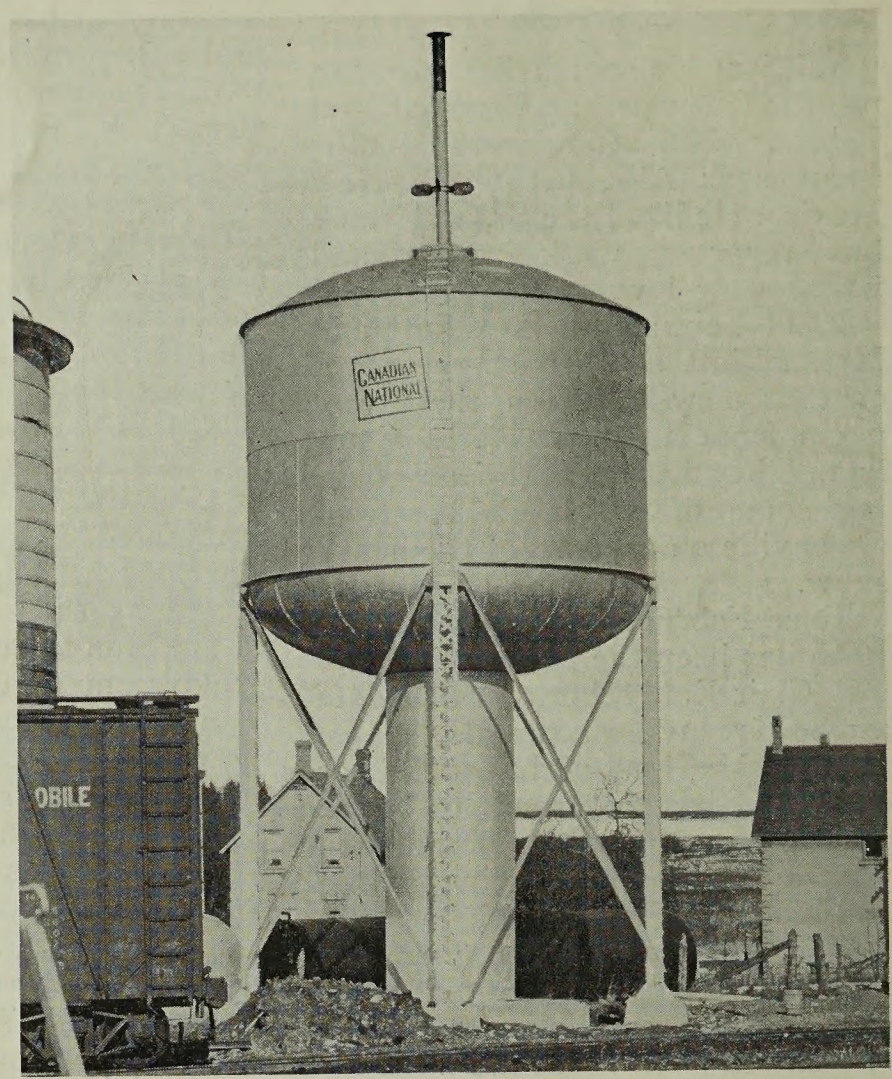
This picture might give the impression that the Greenville plant was fabricating a large number of small welded tanks. This is not the case as the cylinders appearing here are not designed to contain liquid but rather to exclude it. They are floats for Wiggins Breather-Floater Roofs. Open at the top end, they are welded to the under side of the roof. These floats, after shop welding, are tested for tightness in the open top tank seen at the base of the third crane column from the left. Two of these are telescoped together and tack-welded for convenience in handling and shipping. George Callahan's department is responsible for the assembling, welding and testing

Daniels Drills Make Record

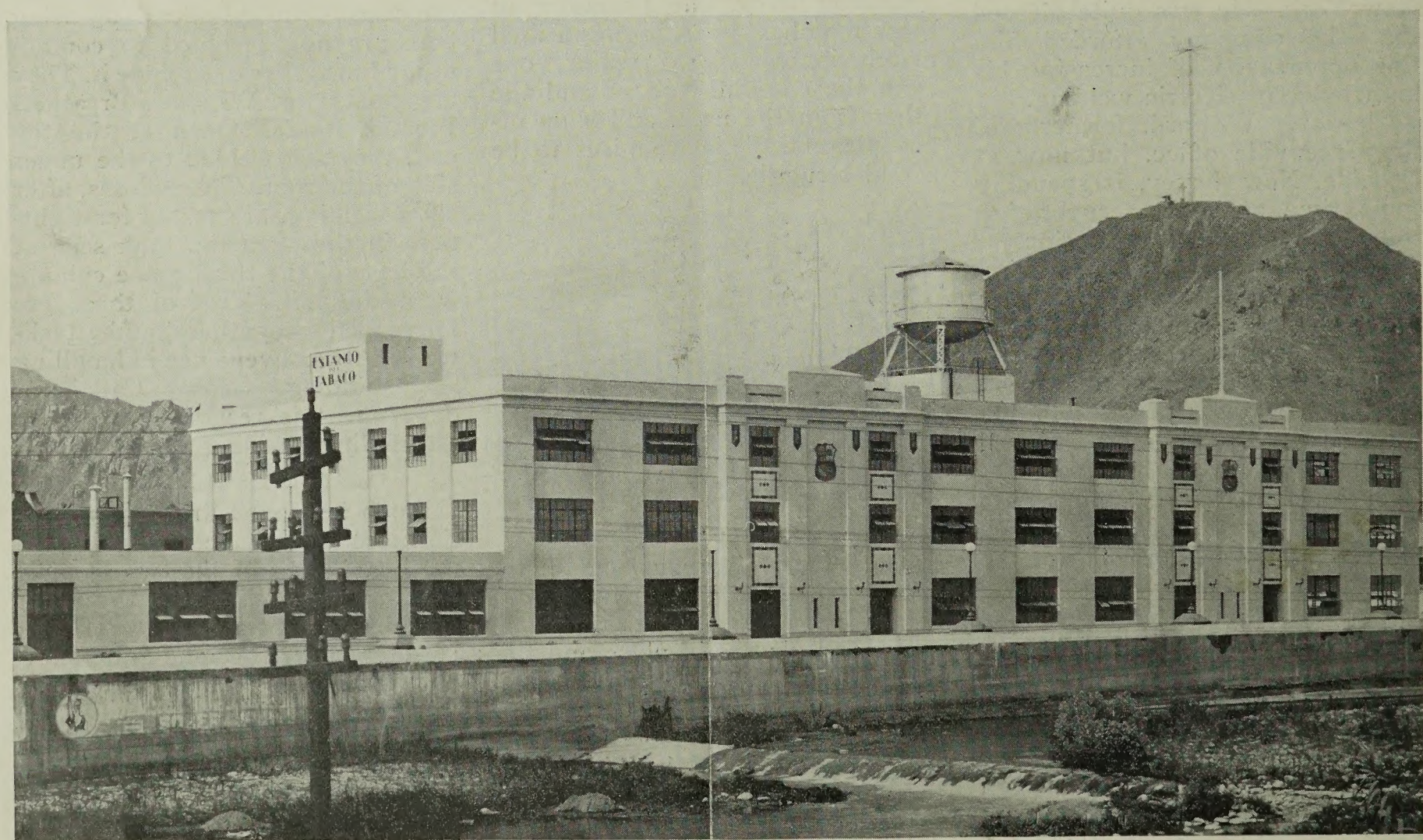
Much improved drilling production and costs have resulted from the installation of the two Daniels drills at Greenville. On the night of February 27th, Operator H. M. Little, who has become quite skillful in handling these machines, using two drills, produced 8,662 holes 13/16 inch in diameter through ⅜-inch plates in 8¾ hours, drilling ten plates in a stack. This night's work was at the rate of 990 holes per hour and at a cost of 7.7 cents per hundred.



25,000-gallon hemispherical-bottom tank at the Country Club de Santiago, Santiago, Cuba. It provides water at a uniform pressure for general service.



40,000 Imperial-gallon tank built for the Canadian National Railways at Hanover, Ontario. A stove is located inside the riser, which acts as a heating chamber.



20,000-gallon Horton elevated tank on industrial building which The Foundation Company erected for the Government of Peru at Lima.